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THE LATE PLEISTOCENE SMALL MAMMALS OF EAGLE CAVE, PENDLETON COUNTY, WEST VIRGINIA

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LOCATION

Eagle (Eagle Rock) Cave, Pendleton County, north-central West Virginia (long 79° 17′ W, lat 38° 50′ N, elevation 2500 feet, Onego Quad. U.S.G.S. 15′ series), is the smallest of several caves in the New Scotland-Coeymans Member of the Helderburg Limestone at the southern end of Cave Mountain (fig. 1). Eagle Cave, about 100 feet below the crest of the mountain, some 1000 feet above the floor of Smokehole Valley, overlooks the South Branch of the Potomac River. High Knob, North Fork Mountain, about three miles west of the cave, rises to a height of almost 3800 feet, some 2300 feet higher than the river. Cave Mountain lies in the Ridge and Valley Province, just east of the Allegheny Front, in one of the most rugged sections of the West Virginia mountains, surrounded by the Monongahela National Forest. The major Cave Mountain caves are discussed in Davies, 1965; Eagle Cave is not.

The cave faces west across the river valley, opposite Dry Hollow and the north end of Pretty Ridge. The valley of the South Branch at this point, and for many miles downstream, i.e., to the north, is physiographically young, narrow, and tortuous. Directly south of the

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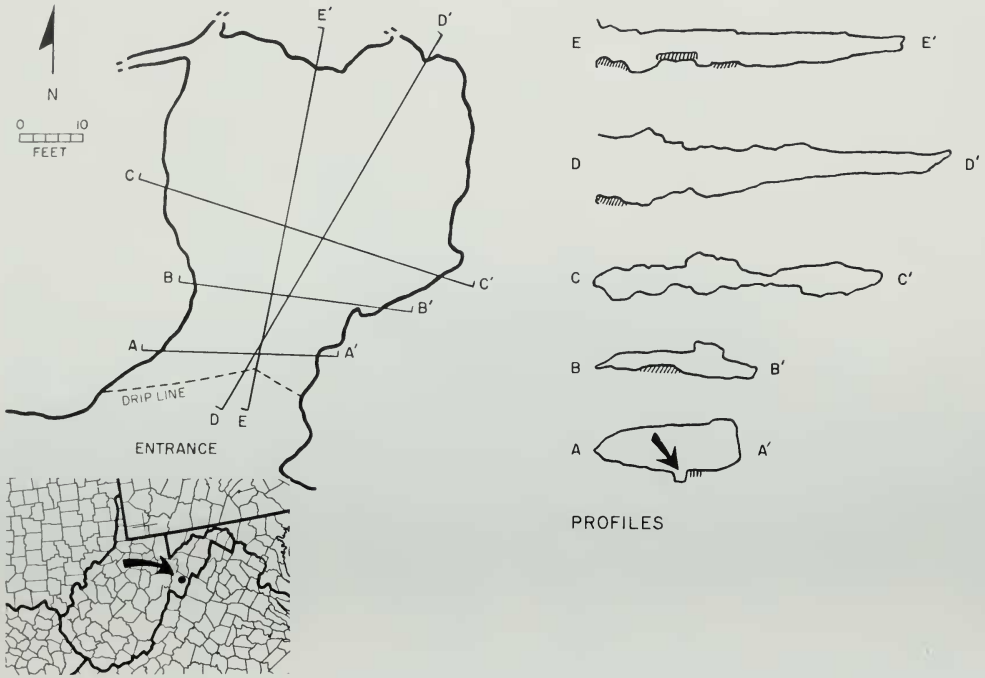

Fig. 1. Map of Eagle Cave, Pendleton County, West Virginia. Arrow in profile A—A′ points to Carnegie Museum excavation. Arrow on insert map, lower left, points to Pendleton County and location of cave.

cave, upstream, the river enters this valley from the east, through the Big Mountain/Cave Mountain gap, from a broad, flat, physiographically older valley. Apparently the South Branch of the Potomac was pirated sometime in the past, its headwaters captured by Smokehole Valley drainage.

DESCRIPTION

Eagle Cave has seen much traffic through the years. There is a picnic area at the base of the mountain at Eagle Rock, and people walk the trail from time to time to visit Cave Mountain in the same outcrop. As a consequence, the floor of Eagle Cave has been badly disturbed. The cave has an entrance about 20 feet wide and seven feet high, and is about 50 feet deep and 40 feet wide. Its height diminishes sharply from front to rear. The floor is littered with breakdown from the roof (fig. 2) and slopes gently in from the cave mouth, where once there had apparently been a talus build-up which has been eroded away. The cave floor at this point had been protected from disturbance for some time by a large ceiling spall weathered on its upper side (fig. 3). This 500-pound rock was removed and a hole four-feet square and from two to three feet deep was excavated to bedrock in the center of the cave immediately behind the drip line. Only a small portion of the total cave floor was excavated (fig. 1). Approximately three-fourths of a ton of matrix was removed by one-foot levels. No evidence of stratification or faunal change with depth was noted—all materials were combined. Matrix was colored deep red to brown, was highly compressed, and appeared to have little moisture in it. It derived from breakdown products of the limestone as well as from erosion debris from higher on the mountain. Approximately 5% of the matrix was composed of small rock fragments from one-fourth inch to one inch in diameter, with occasional larger ones up to five inches in length. All appeared to be of native rock, frost-wedged from the ceiling or walls. Small mammal bones and teeth occurred, sparsely throughout, badly fragmented and with no apparent orientation.

The face of the mountain below the cave is strewn with breakdown from the cave outcrop. The cave mouth in the outcrop faces the prevailing westerlies and is exposed to the full rigor of the weather. Erosion is active, and in a relatively short time any original matrix in this shallow cave will have been eroded away. The floor of the cave is starting to break up near the entrance now.

High on a rocky promontory, this deposit of vertebrate remains was accumulated primarily by raptorial birds. The position of the cave makes it an ideal aerie. Only through the action of wide-ranging nocturnal birds of prey could such a diverse small mammal fauna,

Fig. 2. View toward entrance from rear of Eagle Cave, Pendleton County, West Virginia. Note extensive roof breakdown.

obviously removed from both field and forest situations, accumulate in this out-of-the-way situation. Such birds habitually regurgitate undigested bone in and around their nests, and this in time becomes incorporated into accumulating cave-floor deposits.

A Carnegie Museum field party, led by Hamilton, excavated the site from June 25 to July 6, 1970. We wish to thank Helen and Paul Imblum, Janet and Allen Bailey, Lee Ambrose, Timmy Clair, Rita Hamilton, Allen Hamilton, and Ann Rhunka for their help in excavating this difficult mountain cave, and Charles Schwab for transporting the excavated matrix to the Museum field laboratory at New Paris, Pennsylvania. Research was conducted under National Science Foundation Grant no. GB18706X, made to the senior author.

The abbreviation CM in Table 1 refers to Carnegie Museum. Omission of the degree symbol in temperature readings (e.g., "6—7 F") follows the *Style Manual for Biological Journals* standard.

ENVIRONMENT

The topography of the area is controlled by its geology. The long parallel mountain ridges are of erosion-resistant sandstones, the intermontane valleys less resistant shales and limestones. The Potomac River cuts across the mountain ranges from west to east and apparently

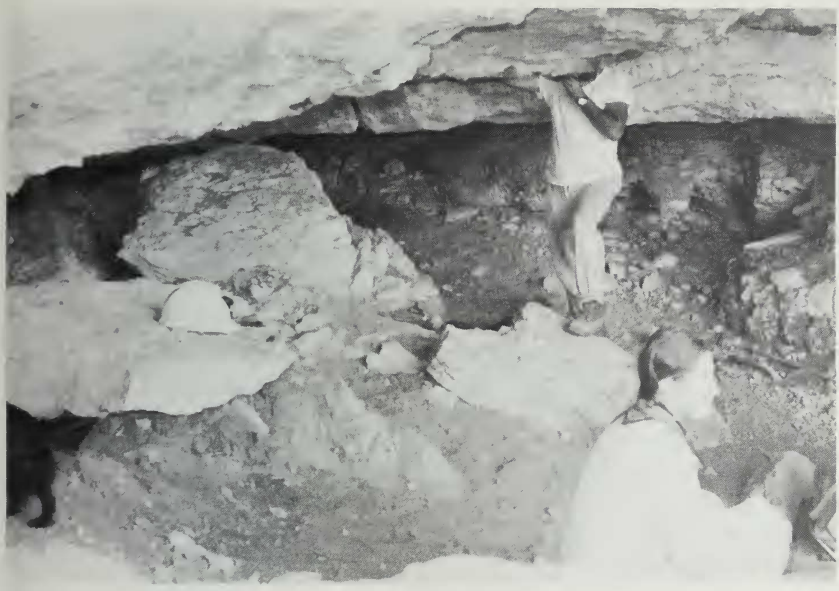

Fig. 3. View into Eagle Cave, Pendleton County, West Virginia, taken from point D (see fig. 1). Note extensive roof breakdown. Man in background stands behind roof spall that was removed prior to excavation.

predates their formation, but its tributaries form parallel branches to the northeast and the southwest following the present valley floors.

Local climate is variable. Annual rainfall on the Allegheny Plateau, 10 miles west of Eagle Cave, varies from 40 to 50 inches per year. Immediately to the east, the Ridge and Valley Section in the rain shadow of the Plateau averages some 10 inches less per year. In 1930, the driest season on record, precipitation was less than 20 inches at some locations on the Plateau. The temperature of the Ridge and Valley Section averages 6 to 7 F higher than that of the summits of the Allegheny Plateau. Clarkson (1966) states that the lowest recorded temperatures are —37 F at Lewisburg, Greenbrier County, and —30 F at Bayard, Grant County. The highest recorded temperature from the Ridge and Valley Section was 104 F. The average growing season on the Plateau is 119 to 145 days, and in the adjacent Ridge and Valley Section, 147 to 150 days. Killing frosts have been reported as late as June 17 and as early as September 10 in some mountain localities.

Prevailing winds are from the west. Much of their moisture is lost as precipitation as they pass over the high Allegheny Plateau, and they become warmer and drier as they reach the Ridge and Valley Section. This difference is significant in the distribution of the flora today.

TABLE 1

EAGLE ROCK LOCAL FAUNA, PENDLETON COUNTY, WEST VIRGINIA

Species	Minimum Number Animals	Level 1	Level 2	Level 3	Minimum Based on:	CM Catalog Number
		Class OSTEICHTHYES				
small fish	sparse	X	X	X	vertebra	24424
		Class AMPHIBIA and REPTILLIA				
small snake, toad / frog	sparse	X	X	X		24429
		Class MAMMALIA Linnaeus, 1758				
		Order INSECTIVORA Bowdich, 1821				
		Family: Soricidae Gray, 1821				
Sorex arcticus Kerr *arctic shrew	1	—	—	X	mandible	24401
Sorex cf. *fumeus* Miller smoky shrew	1	X	—	—	tibia	24400
Blarina brevicauda (Say) short-tailed shrew	7	X	X	X	mandible	24397-24399
Cryptotis parva (Say) least shrew	1	—	—	X	mandible	24421
		Family: Talpidae Gray, 1825				
Parascalops breweri (Bachman) hairy-tailed mole	1	X	X	—	mandible	24413-24414
		Order CHIROPTERA Blumenbach, 1779				
		Family: Vespertilionidae Gray, 1821				
Myotis, ?species a (smaller than b)	1	—	X	—	mandible with M_3	24419
Myotis, ?species b (larger than a)	2	—	—	X	mandible. P_4—M_1; M_2	24420
Myotis Kaup, unassignable fragments	1	X	—	—	M_1	24418

*Not extant in West Virginia since beginning of Colonial times.

TABLE 1
EAGLE ROCK LOCAL FAUNA, PENDLETON COUNTY, WEST VIRGINIA (continued)

Species	Minimum Number Animals	Level 1	Level 2	Level 3	Minimum Based on:	CM Catalog Number
		Order LAGOMORPHA Brandt, 1855				
		Family: Leporidae Gray, 1821				
Leporidae, ?species	1 +	X	X	X	isolated teeth	24423
		Order RODENTIA Bowdich, 1821				
		Family: Sciuridae Gray, 1821				
Marmota monax (Linnaeus) woodchuck	*2*	—	X	—	isolated teeth	24396
Spermophilus tridecemlineatus (Mitchill) *thirteen-lined ground squirrel	*1 or 2*	X	X	—	isolated teeth	24391-24393
Tamiasciurus hudsonicus (Erxleben) red squirrel	*2*	X	X	—	P_4	24389-24390
Glaucomys cf. *sabrinus* (Shaw) northern flying squirrel	*1*	—	X	X	maxilla	24394-24395
		Family: Cricetidae Rochebrune, 1883				
Peromyscus Gloger, ?species probably *P. leucopus* or *P. maniculatus*	*3*	—	X	X	mandible	24416-24417
Neotoma floridana (Ord) woodrat	*7*	X	X	X	M_1	24402-24403, 24415
Clethrionomys gapperi (Vigors) red-backed vole	*4*	X	X	X	M_1	24371, 24379, 24386
Phenacomys cf. *intermedius* Merriam *spruce vole	*1*	—	—	X	M^2	24381
Microtus pennsylvanicus (Ord) meadow vole	*1*	—	X	—	M^3	24376
Microtus chrotorrhinus (Miller) rock vole	*2*	—	X	X	M^3	24373, 24384
Microtus pennsylvanicus or *M. chrotorrhinus*	*8*	X	X	—	M_1	24372, 24374, 24383

*Not extant in West Virginia since beginning of Colonial times.

TABLE 1

EAGLE ROCK LOCAL FAUNA, PENDLETON COUNTY, WEST VIRGINIA (continued)

Species	Minimum Number Animals	Level 1	Level 2	Level 3	Minimum Based on:	CM Catalog Number
Microtus xanthognathus (Leach) *yellow-cheeked vole	1	—	X	—	mandible	24377, 24388
Microtus (Pitymys) pinetorum (Le Conte) pine vole	7	—	X	X	M_1	24375, 24385
Synaptomys cooperi Baird southern bog lemming	1	X	—	—	M_1	24370
Synaptomys borealis (Richardson) *northern bog lemming	1	—	—	X	M_1	24382
Ondatra zibethicus (Linnaeus) muskrat	1	—	X	X	M_2	24380, 24387
Family: Zapodidae Coues, 1875						
Zapus hudsonius (Zimmerman)? meadow jumping mouse ?	1	X	—	—	upper incisor	24422
Family: Erethizontidae Thomas, 1897						
Erethizon dorsatum (Linnaeus) †porcupine	1	—	X	—	partial molar	24426
Family: Castoridae Gray, 1821						
Castor canadensis Kuhl beaver	1	—	X	—	dp4	24427
Order CARNIVORA Bowdich, 1821						
Family: Procyonidae Bonaparte, 1850						
cf. *Procyon lotor* (Linnaeus) raccoon	1	—	—	X	canine	24428
Family: Mustelidae Swainson, 1835						
Martes americana (Turton) *pine marten	1	X	—	—	P^4	24425

*Not extant in West Virginia since beginning of Colonial times.

†Not extant in West Virginia now, but may have been living there in Colonial times.

Originally, the thin, acidic, sandy, well-drained soils of Cave Mountain supported a chestnut/oak forest. The original vegetation of the Ridge and Valley Section, however, is poorly known. The forests along the major streams were destroyed before their composition could be studied. Clarkson (1966:8) states, "On the drier slopes of this section the dominant trees were chestnut [*Castanea*] and chestnut oak [*Quercus prinus*] with mixtures of other oaks . . . In the more mesic situations were found a variety of hardwoods, mainly yellow poplar [*Liriodendron*], hemlock [*Tsuga*], red oak [*Quercus rubra*], white oak [*Quercus alba*], and basswood [*Tilia*] with white oak being the most characteristic tree." At altitudes of 2000 to 2500 feet, northern hardwoods formed a narrow belt on the mountain slopes above the oak/chestnut and below the spruce *(Picea),* composed mainly of yellow birch *(Betula lutea),* sugar maple *(Acer saccharum),* red maple *(A. rubrum),* beech *(Fagus),* and basswood. Along the higher mountains, e.g. North Fork Mountain, 3 miles west of the cave, stands of red spruce *(Picea rubens)* are, or were, found at elevations above 2500 feet. Clarkson (1966:10) writes. "Spruce flourished where the soil and atmospheric moisture were abundant and was able to compete at higher elevations on thin, moist soil with the more exacting species." Grass/sedge meadows occasionally occurred in poorly drained mountain valleys and may well have persisted from late Pleistocene times.

FAUNA

The remains of small fish, frogs, snakes, five species of insectivores, three of bats, 18 of rodents, one lagomorph, and two carnivores were recovered from the excavation. In all, these remains represented a minimum of 68 individual mammals. Porcupine and immature beaver, the largest mammals in the collection, were represented by isolated molars; the smaller rodents and insectivores by upper or lower dentitions or isolated teeth. Remains of larger mammals were conspicuously absent. The cave at no time appears to have formed a natural trap, and the faunal remains are confined to animals small enough to form owl prey. Some of the species, bats and woodrat, probably inhabited the cave, but the presence of nocturnal field and forest forms, and the high number of microtines suggests the activity of owls.

The Eagle Cave local fauna is but one of a number of geographically widespread fossil faunas of Rancholabrean age from the central Appalachians and flanking plateau and piedmont regions. These local faunas have in common a number of Recent Canadian and Hudsonian Life Zone small mammals that occupied the area during some phase of the Wisconsinan glaciation.

The yellow-cheeked vole *(Microtus xanthognathus)* (fig. 4 top), the northern bog lemming *(Synaptomys borealis),* the heather vole *(Phenacomys intermedius),* and the arctic shrew *(Sorex arcticus)*

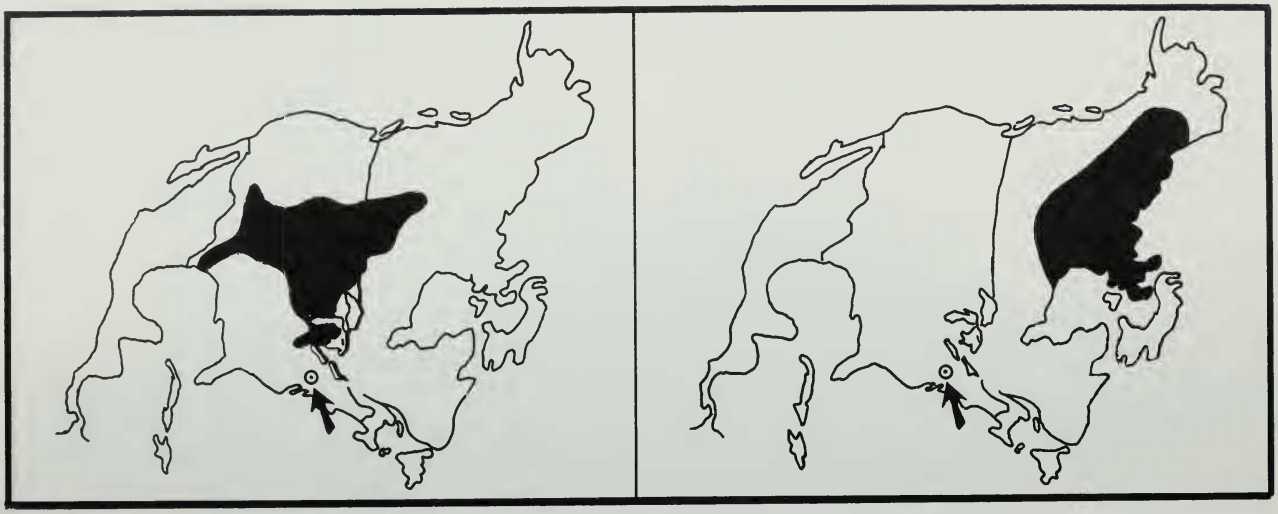

Fig. 4. Upper map: North American range of yellow-cheeked vole [*Microtus xanthognathus* (Leach)]. Arrow points to Eagle Cave, Pendleton County, West Virginia. Lower map: North American range of thirteen-lined ground squirrel [*Spermophilus tridecemlineatus* (Mitchill)]. Arrow points to Eagle Cave.

are species that have since retreated to the north. *Synaptomys borealis,* occurring as far south as northern New England, is the only one of these species still found in the Appalachian Mountains. Remains of these small mammals had not hitherto been recovered from West Virginia, but they form a characteristic element of the early post-Wisconsinan cave deposits of the central Appalachians [New Paris No. 4, Pa., 96 miles to the north (Guilday *et al.,* 1964); Bootlegger Sink, Pa., 162 miles northeast (Guilday *et al.,* 1966); Natural Chimneys, Va., 36 miles southeast (Guilday, 1962); Welsh Cave, Ky., 315 miles west of Eagle Cave (Guilday *et al.,* 1971)]. Two of these local faunas (New Paris No. 4, Pa., Welsh Cave, Ky.) have carbon-14 dates of 11,300 ± 1000 yrs. B.P. (Y-727) and 12,950 ± 550 yrs. B.P. (I-2982).

Another species characteristic of such sites is the thirteen-lined ground squirrel *(Spermophilus tridecemlineatus).* At present it is confined to prairie areas of central North America as far north as southern Canada, and as far east as western Ohio (fig. 4 bottom). The valley of the South Fork of the Potomac, below Eagle Cave, narrow, precipitous, physiographically young, does not appear to have been suitable for grasslands. A few miles upstream, however, as noted above, the river flows through a wide, physiographically older valley whose floor may well have supported grassland features.

Although most other species identified from the Eagle Rock local fauna inhabit the state today, the porcupine and pine marten may have been exterminated during Colonial times. The rock vole *(Microtus chrotorrhinus)* is at present a boreal relict form occurring sporadically in high mountain rocky situations along the crest of the Appalachians as far south as Georgia. It has been recorded as close as 16 miles southwest of the cave, on Spruce Knob, elevation 4700 feet, but has been taken as low as 2750 feet in Greenbrier County (McKeever, MS). The northern flying squirrel *(Glaucomys sabrinus),* the porcupine *(Erethizon dorsatum),* and the pine marten *(Martes americana)* were of limited distribution, confined for the most part to high Canadian Zone forests. The red-backed mouse *(Clethrionomys gapperi)* is another forest animal, ostensibly boreal but less exacting in its requirements. It would be available as prey in the area today. All other species are of wide distribution within the area today.

The presence of the least shrew *(Cryptotis parva),* represented by one lower jaw from the 3-foot level of the excavation, was unexpected. The presence of this primarily southern field form is not in keeping with the boreal aspect of the fauna and may indicate that the deposit accumulated over a long period, incorporating both boreal and temperate elements. But the range of the least shrew and that of the thirteen-lined ground squirrel overlap in a broad area of the north-central United States as far north as southern Minnesota (Hall &

Kelson, 1959), so it is conceivable that the two may have shared the same local grasslands habitat during late Pleistocene times. Both were also present in the Natural Chimneys and Bootlegger Sink local faunas.

Climatic effects most certainly varied with latitude. This appears to be demonstrated by a progressive dropout of some of the small mammals characteristic of these Wisconsinan boreal faunas. The collared lemming *(Dicrostonyx hudsonius),* for instance, has been recorded no farther south than latitude 40° N (New Paris No. 4, Pa.); *Microtus xanthognathus* no farther south than latitude 38° N (Natural Chimneys, Va.). *Synaptomys borealis* and *Phenacomys* occur as far south as latitude 36½° N (Baker's Bluff, Tenn.). West of the Appalachians proper, *M. xanthognathus* occurs at latitude 38° N (Welsh Cave, Ky.), but apparently not as far south as latitude 36° N [Robinson Cave, Tenn. (Guilday *et al.,* 1969)].

Most of these cave faunas have no accompanying large mammal remains because of the circumstances of accumulation and preservation (fossil owl roosts and narrow fissure traps). The several large-mammal concentrations, fluvial and bog, rather than cave deposits, dating from Wisconsinan and early post-Wisconsinan times, rarely possess a small-mammal component [Saltville, Va. (Ray *et al.,* 1967), Big Bone Lick, Ky. (Schultz *et al.,* 1963)]. But these sites are contemporaneous within the broad framework of the Wisconsinan glaciation. The discrepancy shown by the altogether Recent aspect of the small mammals and the high number of extinct large mammals highlights the peculiar nature of the faunistic change that took place approximately 10,000 years ago, when the large mammals were swept by a wave of extinctions that apparently had no effect on the small-mammal component of such faunas.

These Wisconsinan local faunas can be distinguished in the Appalachians from an earlier fauna, pre-Wisconsinan in age and probably Illinoian [Cumberland Cave, Md., for instance (Gidley & Gazin, 1938)]. This earlier fauna is characterized by a high rate of extinction, in contrast to Wisconsinan faunas, of both the large and the small mammal component. The earlier fauna appears to be more continental in composition, containing such forms as pika *(Ochotona)* and western pocket gopher [*Thomomys (Plesiothomomys)*], which seem to be absent from later faunas. The microtines are of primitive aspect. *Neofiber* and *Ondatra annectens* are present, *O. zibethicus* is not. *Atopomys* is present. The progressive forms of *Microtus* (those possessing five closed alternating triangles in M_1) that now inhabit the Appalachians *(M. pennsylvanicus, M. chrotorrhinus),* or did in Wisconsinan times *(M. xanthognathus),* are absent from these Illinoian faunas. Instead, forms of *Microtus* with four alternating triangles, a more primitive

condition, are found. Many small mammals are common to both, but faunas of these two time horizons are quite distinct in their make-up. Much remains to be done to resolve them and to trace the effects upon these fossil faunas of latitude and climatic change along the thousand miles of the Appalachian Mountain system.

Speculation on the ecological implications of the Eagle Cave local fauna, other than in the broadest sense, would be premature. The physiography of the area is rugged, and even under today's temperate climatic regime the area supports varied and distinct biotic communities, because of the effects of altitude, soil conditions, and local rain shadows. Fluctuations in climatic parameters vary within short distances. The situation during the late Pleistocene was undoubtedly just as diverse under more boreal conditions. The amount of bone recovered from the deposit was insufficient for a carbon-14 date, so that its age can be stated only in general terms. The deposit itself is composed of the remains of both grassland and forest forms. These were not, as in a sinkhole trap situation like New Paris No. 4, Pa., recovered from the immediate vicinity, but from any point within the cruising range of the raptorial birds responsible for the accumulation. The deposit gives only a general impression of some combination of boreal forest and grassland. It tells nothing of the extent of either, however. The picture will no doubt come into clearer focus with additional research. Although low in numbers and variety of vertebrate remains compared with some other Appalachian cave sites like New Paris No. 4, Pa., the Eagle Cave deposit is the first late Pleistocene cave deposit to be reported from the state of West Virginia.

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